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WAGE INDEXATION AND THE EFFECT OF INFLATION UNCERTAINTY ON EMPLOYMENT: AN EMPIRICAL ANALYSIS

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A. STEVEN HOLLAND

I. INTRODUCTION

In his Nobel Lecture, Milton Friedman (1977) argued that the greater uncertainty associated with higher inflation leads to a misallocation of resources because of shorter duration of contracts and reduced efficiency of the price system. The result is reduced economic growth and, possibly, more unemployment--i.e., a positively-sloped Phillips Curve--over the fairly long term. In a subsequent article, Levi and Makin (1980) found a significant negative impact of inflation uncertainty on employment growth. Evidence of a similar nature was reported by Amihud (1981) and Ratti (1984), while Mullineaux (1980) found a significant positive effect of inflation uncertainty on the rate of unemployment and a negative effect on industrial production. Given the substantial body of empirical literature linking higher inflation to greater inflation uncertainty, this provides support for Friedman's hypothesis.[1/]

Friedman also noted, however, that in the very long run, institutions should adapt to an inflationary economy in a way that offsets much of the real effect of inflation uncertainty (p. 464):

> Just as the natural-rate hypothesis explains a negatively sloped Phillips Curve over short periods as a temporary phenomenon that will disappear as economic agents adjust their expectations to reality, so a positively sloped Phillips Curve over somewhat longer periods may occur as a transitional phenomenon that will disappear as economic agents adjust not only their expectations but their institutional and political arrangements to a new reality. When this is achieved, I believe that--as the natural-rate hypothesis suggests--the rate of unemployment will be largely independent of the average rate of inflation. . . .

An example of institutional adaptation to greater inflation uncertainty is more widespread indexation of wage contracts.[2/]

The purpose of this article is to estimate the impact of inflation uncertainty on employment, while also considering the second-round effects of labor market adjustments designed to reduce the risk associated with inflation uncertainty. These adjustments are proxied by the prevalence of indexation of wage contracts. Even though formal indexing typically applies only to contracts in the unionized sector--less than 25 percent of the U.S. labor market--this measure should serve the purpose at hand since the behavior of union wages influences the wages of other workers. Furthermore, more widespread indexing should occur at roughly the same time as other adjustments to greater inflation uncertainty such as increasing the degree to which already-indexed wages adjust to price level changes or moving toward greater use of implicit rather than explicit labor contracts.

This article proceeds as follows: Section II discusses the measurement of inflation uncertainty and the level of wage indexation. Estimates of the impact of inflation uncertainty on indexation in the U.S. for the period 1961-83 are also presented. Section III examines the impact of inflation uncertainty and indexation on the growth rate of employment. Section IV presents the results of simulations designed to estimate the long-term impact of inflation uncertainty on the level of employment, given its impact on the level of wage indexation. Concluding remarks are presented in Section V.

II. THE EFFECT OF INFLATION UNCERTAINTY ON THE LEVEL OF INDEXATION

Various proxies for inflation uncertainty have been used in empirical research, including estimates of the variability of inflation rates, the variability of expected inflation rates, and the variability of inflation forecast errors. Levi and Makin used a measure of the variability of inflation expectations based on the dispersion of inflation forecasts across respondents to a survey.[3/] One possible rationale for this approach is that an individual who observes a wider variety of predictions of next period's inflation rate (through published sources, for example) becomes more uncertain about the accuracy of his own forecast, especially if he believes that different forecasts are based on information he does not have.[4/]

A potentially better estimate of inflation uncertainty would be based on the variability of errors in forecasting inflation. Cukierman and Wachtel (1982b) suggest the mean-squared error (MSE) of inflation forecasts from a survey as the best available measure. This is a cross-sectional measure of the dispersion of forecast errors across individuals:

$$(1)\quad MSE_t = \frac{1}{n}\sum_{i=1}^{n}(\dot{p}^*_{it} - \dot{p}_t)^2$$

$$= \frac{1}{n}\sum_{i=1}^{n}(\dot{p}^*_{it} - \bar{\dot{p}}^*_t)^2 + (\bar{\dot{p}}^*_t - \dot{p}_t)^2$$

where n is the number of forecasters, $\dot{p}$ is the actual rate of inflation, $\dot{p}^*_i$ is the rate of inflation forecast by individual i, and $\bar{\dot{p}}^*$ is the mean forecasted rate of inflation among respondents. The first term on the right-hand side of the equation is the variance of individual forecasted values, and the second term is the squared mean forecast error. The square root of the first term (the standard deviation of the forecasts) and the square root of the sum of the two terms (the root-mean-squared error of the forecasts) are used in this study as proxies for inflation uncertainty.

Chart 1 plots the root-mean-squared error (RMSE) of year-end to year-end inflation forecasts from the Livingston survey along with the standard deviation (SD) of the same forecasts from 1960-83.[5/] The two series are positively related, with a correlation coefficient of 0.52, but the RMSE is far more variable than the standard deviation, ranging from less than one to more than 6 percent over the entire period. Both series are substantially higher on average in the 1970s and 1980s than in the 1960s.[6/] The two proxies for inflation uncertainty represent very different notions of how the level of uncertainty changes through time. The RMSE series implies that uncertainty varies widely due primarily to transitory disturbances, while SD implies that changes in uncertainty occur fairly gradually and are more or less sustained.

As stated above, the level of wage indexation is used as a proxy for the degree to which labor markets adjust to greater inflation uncertainty. The indexation measure is the number of workers covered by cost-of-living adjustment (COLA) clauses as a percentage of the total number of workers subject to major collective bargaining contracts.[7/]

To test the impact of inflation uncertainty on the level of indexation, the following equation is estimated using both SD and RMSE as proxies for inflation uncertainty:

$$(2) \quad COLA_t = \alpha_o + \sum_{j=1}^{m} \alpha_j \, COLA_{t-j} + \sum_{k=1}^{q} \beta_k \, U_{t-k} + \varepsilon_{1t}$$

where COLA is the level of wage indexation, U is inflation uncertainty, and ε_1 is a random error term. Lagged values of the dependent variable are included to account for partial adjustment of the current level of indexation to its desired level resulting from the presence of multi-year contracts. The current value of U is not included because the value of COLA in the current year is based solely on contracts negotiated in previous years. Selection of the number of lags used in this and other regressions in the paper is based on standard t- and F-tests.

Table 1 presents the results of ordinary least squares regressions for the period 1961-83 for each measure of inflation uncertainty.[8/] Inflation uncertainty has a significant positive impact on wage indexation in each regression, although the timing of the effect differs. For the standard deviation (SD) of inflation forecasts (column 1), only the previous year's value is significant, while for the root-mean-squared error (RMSE) of the forecast (column 2), two lagged values are significant. The lagged effect is consistent with Friedman's notion that it takes time for institutions to respond to greater inflation uncertainty.

Only one period's lag of the dependent variable was significant in each regression, but its presence implies that the effect of inflation uncertainty on indexation lasts beyond one or two years due to partial adjustment. The cumulative effect of a permanent increase in SD of one percentage point is an increase in COLA of about 39 percentage points, while a permanent increase in RMSE of one percentage point leads to an increase in COLA of about 17.5 percentage points.[9/]

III. THE EFFECTS OF INFLATION UNCERTAINTY AND WAGE INDEXATION ON THE GROWTH RATE OF EMPLOYMENT

A model that considers the relationships between inflation uncertainty, indexation of labor contracts and employment has been developed by Amihud. He shows that in the absence of wage indexation, risk-averse laborers who maximize the utility from leisure and real consumption reduce the supply of labor services offered to the market in the face of greater inflation uncertainty, as long as the substitution effect between leisure and consumption dominates the income effect--i.e., the labor supply function slopes upward. In addition, if an individual's nonlabor income can be hedged against unexpected price level movements, then his supply of labor falls as inflation uncertainty rises, if there is no wage indexation. With either risk-neutral or risk-averse business firms, the overall effect is reduced employment, since the demand for labor either remains the same or falls.[10/] On the other hand, if indexation is complete, inflation uncertainty has no effect on the supply and demand for labor. As Gray (1976) has shown, however, in an economy subject to both real and nominal disturbances the optimal degree of indexing is always less than 100 percent. In such an economy, there will always be a negative effect of inflation uncertainty on employment and employment growth (as long as either the suppliers or demanders of labor are risk averse, and neither are risk preferrers), but a higher degree of indexing will reduce the size of the effect.[11/]

The approach used by Levi and Makin to assess the impact of inflation uncertainty on employment growth was to estimate the following equation using annual data:

$$(3) \quad \dot{e}_t = \lambda + \gamma \, (\dot{p}_t - \dot{p}^*_t) + \tau \, U_t + \varepsilon_{2t}$$

where $\dot{e}$ is the growth rate of employment, $(\dot{p}_t - \dot{p}^*_t)$ is the actual minus the expected rate of inflation, and U is a proxy for inflation uncertainty (in their case, SD). Unanticipated inflation is included in the equation because of the Lucas (1973) effect: producers view some portion of greater-than-expected inflation as an increase in the relative price of their products, so the aggregate level of production and demand for labor increases. It is, therefore, expected to have a positive impact on employment.[12/]

In this section, equation 3 is changed by adding lagged values of U and the current change in the wage indexation variable, $\Delta COLA_t$. Using $\Delta COLA_t$ amounts to restricting the impact of indexation on employment growth over the current and previous year to zero. I also restrict the sum of the coefficients of current and lagged inflation uncertainty to zero.[13/] These restrictions are tested and found to hold for the number of lags chosen. Therefore, the equation to be estimated is:

$$(4)\quad \dot{e}_t = \lambda + \gamma\,(\dot{p}_t + \dot{p}^*_t) + \sum_{r=0}^{s} \tau_r U_{t-r} + \phi\,\Delta COLA_t + \epsilon_{3t},$$

where $\sum_{r=0}^{s} \tau_r = 0$. The mean of the forecasts from the Livingston survey is used as the estimate of $\dot{p}^*$, and both the standard deviation (SD) and the root mean-squared-error (RMSE) of these forecasts are used as proxies for U.[14/]

Table 2 presents the results for the sample period 1961-83. Both measures of inflation uncertainty have significant negative impacts on employment growth over the current and one previous year. Preliminary testing indicated, however, that the effect of SD on $\dot{e}$ was not significantly different from zero after only a two-year lag, while the effect of RMSE required four years to approach zero.[15/] The effect of a change in the level of wage indexation (ΔCOLA) is positive and significant and nearly identical in the two equations. Unanticipated inflation $(\dot{p}_t - \dot{p}^*_t)$ has a significant impact at the 5 percent significance level (one-tailed test) only in the regression using RMSE as the uncertainty measure, but the effect is positive in each regression as predicted by the Lucas theory.[16/]

IV. SIMULATION RESULTS: THE LONG-TERM IMPACT OF INFLATION UNCERTAINTY ON EMPLOYMENT

The evidence presented above suggests that a permanent increase in inflation uncertainty causes the level of employment to fall below its constant growth rate trend, but a subsequent rise in wage indexation causes it to move back toward trend. In this section, simulations are performed using the estimates from Tables 1 and 2 to determine the extent to which greater indexation offsets the effects of inflation uncertainty on employment and to see how long it takes for the system to converge to a new steady state after a permanent shock.

In the first simulation, the standard deviation of the inflation forecasts (SD) increases permanently in year 1 by 1.0 percentage point from a steady state in which the growth rate of employment ($\dot{e}$) is 1.84 percent (the constant term in column 1, Table 2) and the level of wage indexation (COLA) is arbitrarily chosen to be 20 percent.[17/] The simulated values of COLA and of the percentage deviation of the level of employment from its constant growth rate trend are presented in the first two columns of Table 3. COLA rises to 30.5 percent in year 2 and continues to increase at a declining rate until it is just over 59 percent. By year 14, the level of COLA has reached 58.5 percent. The level of employment is almost 4 percent below trend in year 2 and then increases toward trend in subsequent years. In the long term, the permanent rise in inflation uncertainty results in employment being about 1.15 percent below what it would otherwise have been. The adjustment is essentially complete by year 17. Thus, Friedman's notion that it could take a number of years for the economy to adjust to greater inflation uncertainty is borne out by these simulation results.[18]

Simulations using the other measure of inflation uncertainty, the RMSE of the forecasts, lead to similar conclusions. The simulated effects of a permanent increase in RMSE of 1.0 percentage point (with no change in $(\dot{p}_t - p_t^*)$) on COLA and on the percentage deviation of employment from trend are presented in columns 3 and 4 of Table 3.[19] COLA increases more slowly initially than in the other simulation and takes longer to approach its new equilibrium level; it does not arrive at 36.5 percent (on its way to just over 37 percent) until year 22. The deviation of employment from trend reaches a maximum of 1.41 percent in year 4 and then falls to 0.24 percent by year 25. Therefore, the specification using RMSE as the measure of inflation uncertainty shows a longer adjustment period than the specification using SD. The basic result is the same, however: the impact of wage indexation offsets a large part, but not all, of the effect of a permanent change in inflation uncertainty on the level of employment.[20]

V. CONCLUSIONS

The evidence presented here shows that a permanent increase in inflation uncertainty has a depressing influence on employment initially, but then the labor market adapts in a way that offsets most, but not all, of the effect in later periods. The mechanism through which this occurs is a higher percentage of indexed labor contracts (and presumably a greater degree of adjustment of wages to price level changes in already-indexed contracts), which increases the labor services provided by risk-averse laborers and the demand for labor by risk-averse business firms. To the extent that higher inflation induces greater inflation uncertainty, these findings support Friedman's notion that a positively-sloped Phillips Curve exists over a fairly long interim period, but in the very long run, the economy moves back toward a natural rate of unemployment.

FOOTNOTES

1/ Holland (1984a) provides a review of this literature.

2/ Levi and Makin recognized the potential impact of indexing but did not attempt to estimate it (p. 1,026): "To the extent that inflation uncertainty persists and causes lower employment, our results tend to support the case for a wider use of indexing of nominal contracts, which should reduce the impact of uncertainty felt on the real sector."

3/ Several other studies have used this type of proxy for inflation uncertainty including Mullineaux, Amihud, and Ratti.

4/ This type of partial information framework for explaining nonuniform inflation expectations is used by Cukierman and Wachtel (1982a).

5/ The survey by Joseph Livingston of The Philadelphia Inquirer asks respondents to predict a number of economic indicators including the Consumer Price Index (CPI). The year-end to year-end forecasts used here are actually 14-month forecasts since respondents are thought to know only the level of the October CPI when they turn in their prediction in December of the level of the CPI for the following December. With this in mind, Carlson (1977) has revised Livingston's data on inflation expectations, and this revised data (updated through 1983) is used here.

6/ Note that the three highest values of RMSE occur for the years of energy shocks, 1973-74 and 1979, and that large increases in SD occur during these periods as well. In Holland

(1984a), I found that both higher inflation and energy shocks affect these two measures of inflation uncertainty.

7/ The data on cost-of-living adjustments from 1960-70 come from Hendricks and Kahn (1983). For 1971-83, the data are from the Monthly Labor Review. Major collective bargaining agreements are those that apply to 1,000 or more workers.

8/ There is evidence of serial correlation in the regression using SD as the proxy for inflation uncertainty, but not in the one using RMSE. The result is not affected by reestimating the equation using the Cochrane-Orcutt technique, however, so the OLS result is reported.

9/ Each equation in Table 1 should properly be considered a linear approximation of a nonlinear model, because COLA cannot be greater than 100 (percent). Therefore, the estimates apply to levels of RMSE in the neighborhood of those experienced during the sample period.

10/ The measured rate of unemployment may increase despite the assumption of labor market equilibrium because of people continuing to search for a job even though they are unwilling to accept one at the prevailing wage rate.

11/ For a more detailed discussion of the impact of inflation uncertainty on the labor market, see Holland (1984b).

12/ Although the Lucas model assumes that prices adjust to clear markets in each period, a couple of assumptions allow us to incorporate this effect in a model based on contracting:

(1) only wages, not prices, are set by contract, and (2) once the nominal wage is agreed upon, firms determine the level of employment in accordance with the actual real wage. This implies a further increase in employment arising from unanticipated inflation, since the quantity of labor demanded increases as the real wage falls. The second assumption differs from that used in my earlier article (Holland, 1984b).

13/ A nonzero sum of the coefficients of current and lagged U would imply that permanently higher inflation uncertainty has a permanent effect on the growth rate of employment, which, in principle, should be determined in the long run by demographic factors. A permanent effect on the level of employment, however, can result from transitory changes in the growth rate. Levi and Makin's finding of a permanent impact of inflation uncertainty on the growth rate of employment is probably due to their concentration on the contemporaneous impact. Amihud avoids the problem by using the level of employment instead of the growth rate, while Ratti uses the growth rate but specifies an automatic tendency for employment to return to its natural level, determined at a given point in time irrespective of the level of inflation uncertainty.

14/ Total employment of the Civilian Labor Force (seasonally adjusted) is the measure of e. Growth rates are fourth quarter to fourth quarter log differences.

15/ In the unrestricted regressions, the sum of the coefficients for the current and two lagged values of SD is -0.65, with a t-statistic of -1.09; for the current and four lagged values of RMSE, the sum of the coefficients is -0.31, with a t-statistic of -1.28. Additional lagged values were not statistically significant, but adding them to the equations resulted in the sums of the coefficients coming closer to zero in both cases.

16/ None of the results in this paper were altered when dummy variables were added to the regressions to account for the possible effects of energy shocks in 1973-75 and 1979-81.

17/ To provide some perspective, the mean of SD is about 0.7 percentage points higher for the period 1973-83 than for 1960-72.

18/ One problem in interpreting these simulation results is that they could overstate the long-term effect of inflation uncertainty on employment if inflation uncertainty rises as a result of previous bouts of unanticipated inflation. Unanticipated inflation pushes the <u>level</u> of employment permanently higher, although the effect was not statistically significant in the regression using SD as the uncertainty measure. This means that employment would be above trend when the change in uncertainty occurs.

19/ The mean of RMSE is about 2.0 percentage points higher for the period 1973-83 than for 1960-72. The steady state value of $\dot{e}$ is 1.54.

[20] The value of RMSE is also increased by either positive or negative unanticipated inflation, but assuming these are transitory shocks, they have no long-term impact on either the level of wage indexation or employment. Of course, the initial effect of positive unanticipated inflation is expansionary, but the uncertainty effect offsets this rapidly. The initial depressing effect of negative unanticipated inflation is reinforced by the uncertainty effect, but this is also offset fairly soon. Positive and negative unanticipated inflation each cause the same temporary increase in COLA, because they temporarily increase RMSE.

Table 1
The Impact of Inflation Uncertainty on Wage Indexation, 1961-83

	(1)	(2)
Uncertainty Measure	SD	RMSE
Constant	-0.10 (-0.04)	1.00 (0.35)
$COLA_{t-1}$	0.73 (8.41)	0.84 (11.45)
U_{t-1}	10.51 (3.72)	0.82 (1.19)
U_{t-2}	---	1.98 (2.77)
Sum	---	2.80 (3.56)
$\bar{R}^2$	0.91	0.91
S.E.	4.64	4.74
Dh	1.90	0.36

t-statistics are in parentheses.

Table 2
The Impacts of Inflation Uncertainty and Wage Indexation on Employment Growth, 1961-83

	(1)	(2)
Uncertainty Measure	SD	RMSE
Constant	1.84 (6.76)	1.58 (5.48)
$\dot{P}_t - \dot{P}_t^*$	0.20 (1.47)	0.35 (1.89)
U_t	-2.06 (-2.14)	-0.20 (-0.79)
U_{t-1}	-0.96 (-0.63)	-0.56 (-2.69)
U_{t-2}	3.02 (3.44)	0.17 (0.79)
U_{t-3}	---	0.08 (0.38)
U_{t-4}	---	0.50 (2.98)
Δ COLA	0.10 (2.25)	0.11 (2.42)
$\bar{R}^2$	0.51	0.52
S.E.	1.06	1.05
D.W.	1.76	2.06

t-statistics are in parentheses.

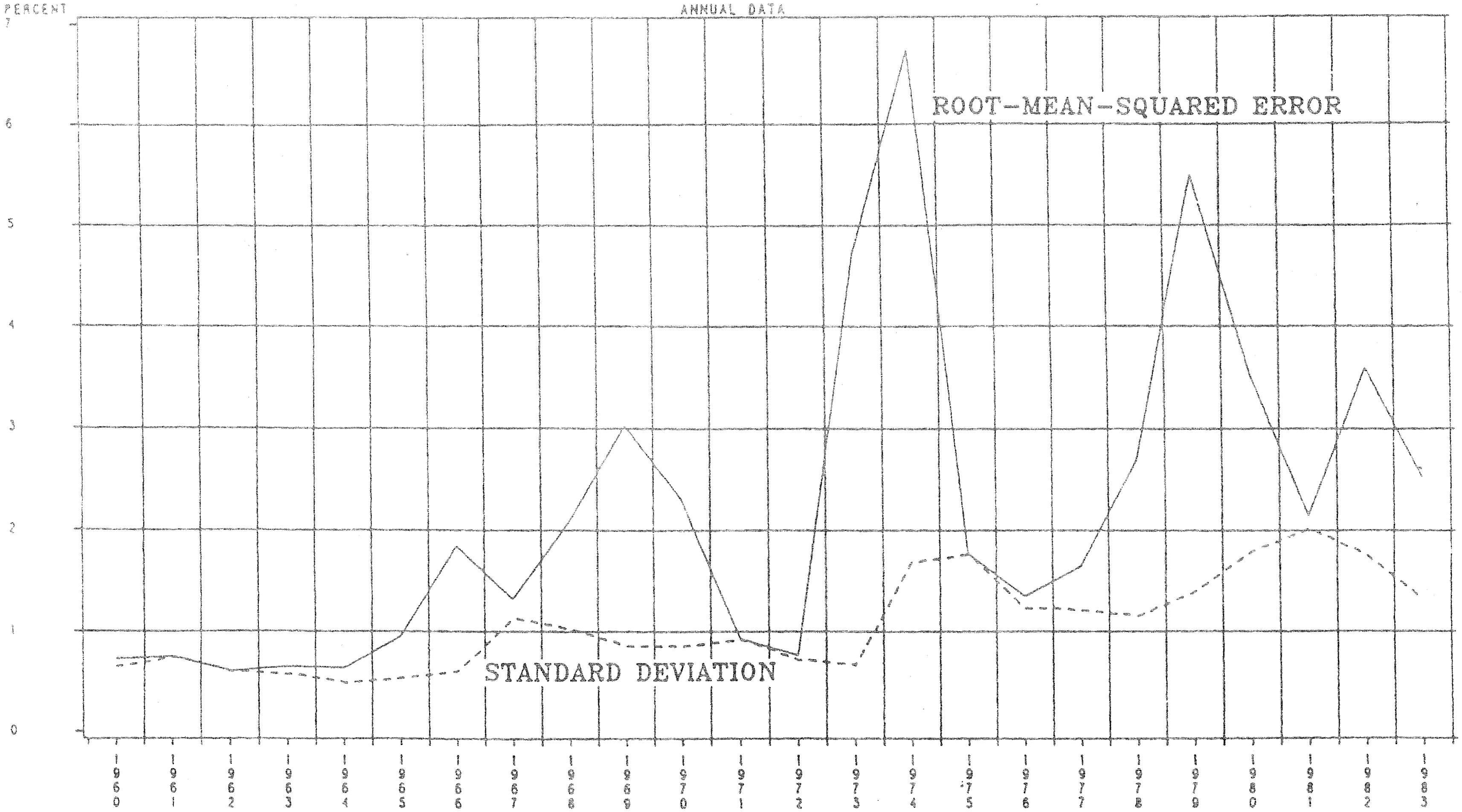
TABLE 3
SIMULATION RESULTS: INDEXED WAGE CONTRACTS (COLA) AND PERCENTAGE DEVIATION OF EMPLOYMENT (E) FROM CONSTANT GROWTH RATE TREND

YEAR	(1) COLA SHOCK TO SD	(2) % DEVIATION OF E SHOCK TO SD	(3) COLA SHOCK TO RMSE	(4) % DEVIATION OF E SHOCK TO RMSE
0	20.0	0.00	20.0	0.00
1	20.0	-2.04	20.0	-0.20
2	30.5	-3.93	20.8	-0.87
3	38.2	-3.18	23.4	-1.16
4	43.8	-2.63	25.7	-1.41
5	48.0	-2.22	27.5	-1.21
6	51.0	-1.92	29.1	-1.05
7	53.2	-1.70	30.4	-0.91
8	54.8	-1.54	31.4	-0.79
9	56.0	-1.43	32.4	-0.70
10	56.9	-1.34	33.1	-0.62
11	57.5	-1.28	33.7	-0.55
12	58.0	-1.24	34.3	-0.49
13	58.3	-1.20	34.7	-0.45
14	58.6	-1.18	35.1	-0.41
15	58.8	-1.17	35.4	-0.37
16	58.9	-1.16	35.6	-0.35
17	59.0	-1.15	35.9	-0.33
18	59.1	-1.15	36.0	-0.31
19	59.1	-1.14	36.2	-0.29
20	59.2	-1.14	36.3	-0.28
21	59.2	-1.14	36.4	-0.27
22	59.2	-1.14	36.5	-0.26
23	59.2	-1.15	36.6	-0.25
24	59.3	-1.15	36.7	-0.25
25	59.3	-1.15	36.7	-0.24
26	59.3	-1.15	36.7	-0.24

CHART 1

ROOT-MEAN-SQUARED ERROR AND STANDARD DEVIATION OF TWELVE-MONTH INFLATION FORECASTS

ANNUAL DATA



SOURCE: LIVINGSTON SURVEY AND FEDERAL RESERVE BANK OF ST. LOUIS.

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